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WILL 2,4-D CONTROL SIERRA LARKSPUR?

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Larkspur, a well-known member of the buttercup family, is represented by more than 60 native species in the western United States and occurs commonly on well-drained loamy soils in the foothills and mountain ranges. Generally the species are classed as tall or low larkspurs. Although species of both groups are considered poisonous to cattle, under range conditions it is doubtful that all are a serious threat. All plant parts are toxic. The tall larkspurs are only slightly poisonous after flowering, while the low larkspurs are poisonous throughout the plant's life. Under range conditions horses and sheep are not affected by the toxic properties of larkspur, but in forced feeding tests poisoning has occurred. Horses rarely eat enough of the plant to harm them, and sheep seem to be immune. Cattle losses are greatest in spring and early summer because of the abundant foliage produced by larkspur in advance of other vegetation.

Local infestations of Sierra larkspur (Delphinium glaucescens) on Beaverhead National Forest summer ranges result in continued losses of cattle annually. These losses have occurred despite increased control of livestock by riding and some changes in management systems. In addition, the scattered occurrence of larkspur plants on the most productive sites restricts the use of a considerable acreage having a better-than-average grazing capacity. Control of larkspur would result in more efficient use of these ranges and would ease the grazing pressure on the lower, less productive sites.

Studies of larkspur control measures have been rather limited. Aldous (1) 2/ reported satisfactory larkspur eradication by grubbing on the Stanislaus National Forest in California. This method was used with somewhat less success in Montana in the early 1930's. Sodium chlorate applied during the active growing period has been reported to control larkspur effectively (3). However, toxicity to livestock and inflammability limit its use. Calcium chlorate has also been used but is less effective as a control measure. Although moderately susceptible to 2,4-D, 3/ larkspur was not controlled by this herbicide in recent tests (2, 4).

1/ Acknowledgement is made to the Beaverhead National Forest for assistance in this study.

2/ Underlined numbers in parentheses refer to Literature Cited listed at the end of this report.

3/ 2,4-D = Dichlorophenoxyacetic acid.

In 1949 a cooperative study with the Beaverhead National Forest was initiated near the Vigilante Experimental Range to determine the effectiveness of 2,4-D in killing Sierra larkspur. Included in the study was a comparison of the effectiveness of three concentrations of 2,4-D in relation to certain larkspur growth stages. This paper reports the results of the study.

THE STUDY

The study was conducted in a typical mountain grassland at an elevation of about 8000 feet. The soil was a deep sandy loam with an average gradient of 18 percent to the north. The vegetation was dominated by Sierra larkspur, sticky geranium (Geranium viscosissimum), and lupine (Lupinus spp.) with lesser amounts of Idaho fescue (Festuca idahoensis), bearded wheatgrass (Agropyron subsecundum), and bluegrass (Poa spp.) present.

Sixty permanent 100-foot transects spaced 5 feet apart were located on two larkspur-infested areas. Along each transect 10 larkspur plants were selected, permanently marked for future reference, and observed as to growth stage. To avoid clustering of treatment replication, a restricted form of randomization was used to assign transect treatment. The transects of each area were grouped into units of 4 and one of the following treatments randomly assigned to each transect within a group: control (untreated), sprayed with a solution of 2000, 4000, or 6000 parts of 2,4-D per million parts (ppm) of water. On the two areas each treatment was applied to 140 individual larkspur plants. The commercial product "Weed No More" containing 40 percent butyl ester of 2,4-D was used. All selected plants along any one transect received the treatment assigned that transect.

One area was treated on June 30, 1949, using a Banta-Driscoll portable sprayer. The aerial portions of the selected larkspur plants were thoroughly wetted. Nearly all plants were in the early growth stages. Plants in more advanced growth stages were similarly treated on July 20, 1949, on the second area.

The selected plants were observed several times during the season to determine the immediate effects of 2,4-D. One year after spraying the treated and untreated plants were relocated and examined to determine their condition and any residual effects of treatment. Thirteen to seventeen percent of the plants in the treatment groups were lost because of marker distrubance by elk. Of the plant locations successfully identified, absence or presence of plants and growth stage were recorded.

RESULTS

Sprayed larkspur plants showed the effects of 2,4-D within 2 weeks. The 4000 and 6000 ppm solutions disturbed growth to a greater degree than the 2000 ppm solution. Typical effects of treatment on individual plants one month after spraying are shown in figure 1.

The 1950 observations showing the proportion of dead plants by growth-stage classes and treatments are summarized in table 1. The data from both areas were consolidated into three growth-stage classes to facilitate statistical analysis. In doing so, similar stages of plant development were considered synonomous regardless of season, e.g., a plant classed in the bud stage on June 30 was assumed to be as advanced physiologically as a plant in the same

Before treatment

After treatment

Figure 1. Typical early effects of 2,4-D on larkspur plants. Photos taken before and one month after treatment.

stage observed and sprayed on July 20. The consolidation of these data permits comparison of plants within the three growth stages. The vegetative class, however, is comprised only of plants from the earlier sample. Only a very small proportion of nonflowering plants were found in the later sample.

Table 1. Proportion of larkspur plants dead by growth-stage class and treatment one year after spraying

Growth-stage class	Percent of plants dead by treatment			
	Control	2000 ppm	4000 ppm	6000 ppm
Vegetative	39	33	33	29
Bud	20	9	25	20
Bloom	11	3	11	10
All classes	23	15	23	20

Statistical analyses (Appendix, table A-1) indicate that 2,4-D in the concentrations used was not effective in killing Sierra larkspur at any of the indicated growth-stage classes. The mortality of untreated plants was as great or greater than that of treated plants.

Mortality observed on the control transects apparently was due solely to natural causes. Mortality on the treated transects during the year approximated 20 percent, slightly less than the average loss from natural causes. The mortality rate on all control and treated transects was not constant between developmental stages. Loss was highest in the vegetative stage and progressively less in the bud and bloom stages. This indicates that larkspur plants are more susceptible to disturbance from whatever causes in the early growth stages. Further evidence of the association of mortality with larkspur growth stages is shown by direct comparison of the two samples taken on June 30 and July 20. Including both treated and untreated plants, the earlier sample, made up of plants all in bud and earlier stages, showed 24 percent mortality compared with 9 percent for the later sample, three-fourths of which was composed of plants in the bloom stage. A similar condition was found when only untreated plants from the two sampling dates were considered.

There were no apparent residual effects of 2,4-D. Distorted growth of treated plants was not evident one year later, nor was flowering ability of the treated plants noticeably impaired. Based on the growth stages of plants at the time of treatment in 1949, the proportion of treated plants flowering in 1950 showed no consistent differences that appeared assignable to treatment when compared with the controls (table 2).

Table 2. Proportion of larkspur plants flowering in 1950 by 1949 growth-stage class and treatment

Growth stage 1949	Percent of flowering plants by treatment			
	Control	2000 ppm	4000 ppm	6000 ppm
Vegetative	36	41	15	24
Bud	68	68	59	57
Bloom	46	68	63	59
All stages	50	59	46	47

DISCUSSION AND SUMMARY

This study shows that the three concentrations of 2,4-D applied in late June or July as contact sprays had no lethal effect on Sierra larkspur. (The results are not intended to be discriminatory against the product used in this study.) Normal growth was disrupted soon after spraying and many of the treated plants appeared to have died. However, examination one year later showed that injury was not permanent.

The reproductive processes of larkspur plants were not permanently affected by 2,4-D. Treating with 2,4-D in 1949 disrupted the normal physiology of the plants and prevented the maturation of flowers and seeds in that season. However, there was no indication of residual effects when the treated plants were re-examined the following year.

Natural mortality from unknown causes was found to be associated with developmental stage of the plants. Higher mortality of plants in the early vegetative stage suggests that this may be a critical period in the plant's life or that at this time of the season a greater part of the population is made up of seedlings which fail to become established. This phase was not investigated. Future investigations should include tests of earlier dates and other materials than those used in this study.

LITERATURE CITED

(1) Aldous
1917. Eradicating tall larkspur on cattle ranges in the national forests. U. S. Dept. Agr. Farmers' Bull. No. 286.

(2) Bohmont, Dale W.
1949. Using 2,4-D in Wyoming. University of Wyoming Agr. Exp. Sta. Bull. No. 291.

(3) U. S. Forest Service
1940. Range plant handbook.

(4) Warden, Robert L., et al
1949. Recommendations for chemical weed control in Montana for 1949. Montana Extension Service Bull. No. 256.

APPENDIX

Table A-1. Analysis of variance of percent dead larkspur plants in 1950 and comparisons of growth stage mean differences

Source of variation	df	Mean square	"F"
Growth stage	2	624	36.71*
Treatment	3	43	2.53
Remainder	6	17	
Total	11		

Growth stage comparisons	Mean difference	"K" 1/
Vegetative and bud	15.25	4.4643*
Vegetative and bloom	24.75	10.0692*
Bud and bloom	9.50	2.8367*

* Significant beyond 1 percent level.
1/ Relative deviate.